

**What is claimed is:**

- 1                   1.     A spot beam hopping packet scheduler system receiving  
2     downlink cell ID and burst memory pointers from a burst assembly and  
3     congestion controller, said spot beam hopping packet scheduler system  
4     providing burst information to an antenna controller and modulator, said spot  
5     beam hopping packet scheduler system comprising:  
6                   a downlink queue coupled to said burst assembly and congestion  
7     controller, said downlink queue receiving and storing said downlink cell ID and  
8     burst memory pointers;  
9                   a cache coupled to said downlink queue, said cache receiving and  
10    storing said downlink cell ID and burst memory pointers from said downlink  
11    queue;  
12                  a downlink search controller coupled to said downlink queue and  
13    said cache, said downlink search controller having control logic operative to  
14    search said downlink queue for packet bursts, and fill any empty cache slots  
15    with data from said downlink queue; and  
16                  a cache search controller coupled to said cache, said cache search  
17    controller having control logic operative to select a seed packet from said cache  
18    in statistically weighted order, select compatible packets from said cache with  
19    statistically weighted order and assign packet bursts to spot beams.
- 1                   2.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, further comprising a plurality of pointer output registers  
3     coupled to said cache and receiving downlink cell ID and burst memory  
4     pointers, said plurality of pointer output registers providing burst information to  
5     said antenna controller and modulators.

1           3.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said downlink queue includes a ping side and a pong  
3     side, whereby said downlink queue swaps said ping side and said pong side  
4     when Cache Depth/2 time slots expire.

1           4.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said cache includes a plurality of left hand pole Cell  
3     IDs and a plurality of right hand pole Cell IDs.

1           5.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said seed packet burst is selected in a round-robin  
3     method across a pre-configured downlink cell range, using a starting point for a  
4     search to find said seed packet burst by searching in a pre-configured seed  
5     search mode, said seed mode consisting of Mode 1 seed and Mode 0 seed  
6     search.

1           6.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said seed packet burst is selected in a round-robin  
3     method across a pre-configured downlink cell range, using a starting point for a  
4     search to find said seed packet burst by searching in a pre-configured seed  
5     mode, said seed mode consisting of skipping mode and/or the non-skipping  
6     mode.

1           7.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said non-seed packet bursts compatible with the seed  
3     packet burst and each other are searched in a round-robin method across a pre-  
4     configured downlink cell range, said compatibility of non-seed packet bursts  
5     determined by checking beam angle isolation, beam amplifier power, aggregate  
6     target power, and cache count.

1           8.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said downlink cell range contains a pre-configured  
3     search order table of Cell IDs with ability for a multiplicity of identical cell ID  
4     entries to provide a statistically weighted fair queuing proportional to said  
5     multiplicity in order to provide advanced control over quality of service, said  
6     pre-configured downlink cell range allowing unique settings between time slots  
7     to dedicate time slots for selected geographic regions and provide quality of  
8     service which can be unique between time slots.

1           9.     The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said burst packet is extracted from said downlink  
3     queue using a shuffling method.

1           10.    The spot beam hopping packet scheduler system as  
2     recited in claim 1, wherein said cache includes a plurality of memory locations,  
3     each of said memory locations having a first in, first out queue.

1           11.    The spot beam hopping packet scheduler system as  
2     recited in claim 1, further comprising said cache skip flags to skip moving  
3     subsequent packet bursts from said downlink queue to said cache if the first  
4     packet burst for respective cell ID was not moved due to said respective cache  
5     FIFO queue being full. Thus, the said skip flags preserve a first in first out  
6     (FIFO) packet burst order for a given destination Cell ID.

1                   12. The satellite system having an apparatus for spot beam  
2 hopping packet scheduling, said apparatus receiving downlink cell ID and burst  
3 memory pointers from a burst assembly and congestion controller, said  
4 apparatus providing burst information to an antenna controller and modulators,  
5 said satellite system comprising:

6                   a ground station;

7                   a satellite in orbit and in communication with said ground  
8 station, said satellite having an apparatus for spot beam hopping packet  
9 scheduling comprising:

10                   a downlink queue located in said satellite and coupled to  
11 said burst assembly and congestion controller, said downlink  
12 queue receiving and storing said downlink cell ID and burst  
13 memory pointers;

14                   a cache located in said satellite and coupled to said  
15 downlink queue, said cache receiving and storing said downlink  
16 cell ID and burst memory pointers from said downlink queue;

17                   a downlink search controller located in said satellite and  
18 coupled to said downlink queue and said cache, said downlink  
19 queue search controller having control logic operative to search  
20 said downlink queue for packet bursts, and fill any empty cache  
21 slots with data from said downlink queue; and

22                   a cache search controller located in said satellite and  
23 coupled to said cache, said cache search controller having control  
24 logic operative to select a seed packet from said cache in  
25 statistically weighted order, select compatible packets from said  
26 cache with statistically weighted order and assign packet bursts  
27 to spot beams.

1           13. The satellite system as recited in claim 12, further  
2 comprising a plurality of pointer output registers coupled to said cache and  
3 receiving downlink cell ID and burst memory pointers, said plurality of pointer  
4 output registers providing burst information to said antenna controller and  
5 modulators.

1           14. The satellite system as recited in claim 12, wherein said  
2 downlink queue includes a ping side and a pong side, whereby said downlink  
3 queue swaps said ping side and said pong side when Cache Depth/2 time slots  
4 expire (with options for a plurality of ping and pong buffers for implementation  
5 optimizations based on the optimization rule where the total number of  
6 ping/pong buffers is equal to a minimum of two and a nominal of one more than  
7 the desired downlink queue size divided by the desired optimum physical buffer  
8 size).

1           15. The satellite system as recited in claim 12, wherein said  
2 cache includes a plurality of left hand pole Cell IDs and a plurality of right hand  
3 pole Cell IDs.

1           16. The satellite system as recited in claim 12, wherein said  
2 seed packet burst is selected in a round-robin method across a pre-configured  
3 downlink cell range. The starting point of the search to find the seed packet  
4 burst is determined by searching in a pre-configured seed search mode. The  
5 said seed search mode consists of either the skipping seed search where the Cell  
6 IDs in the said Cache are skipped.

1                   17. The satellite system as recited in claim 12, wherein said  
2 seed packet burst is selected in a round-robin method across a pre-configured  
3 downlink cell range. The starting point of the search to find the seed packet  
4 burst is determined by searching in a pre-configured seed mode. The said seed  
5 mode consists of either the skipping mode where the Cell IDs in the said Cache  
6 are selected in a round-robin manner over a pre-configured Cell ID search order  
7 and are skipped if the Cache FIFO queue for that Cell ID is empty, or the non-  
8 skipping mode where the Cell IDs in the said Cache are selected in a round-  
9 robin manner over a pre-configured Cell ID order regardless of whether the  
10 Cache FIFO for the corresponding Cell ID is empty or not.

1                   18. The satellite system as recited in claim 12, wherein said  
2 non-seed packet bursts compatible with the seed packet burst and each other are  
3 searched in a round-robin method across a pre-configured downlink cell range.  
4 The said compatibility of non-seed packet bursts is determined by checking  
5 beam angle isolation, beam amplifier power, aggregate target power, and cache  
6 count.

1                   19. The satellite system as recited in claim 12, wherein said  
2 downlink cell range contains a pre-configured search order table of Cell IDs  
3 with ability for a multiplicity of identical cell ID entries to provide a statistically  
4 weighted fair queuing proportional to said multiplicity in order to provide  
5 advanced control over quality of service. The said pre-configured downlink cell  
6 range allows unique settings between time slots to dedicate time slots for  
7 selected geographic regions and/or provide quality of service which can be  
8 unique between time slots.

1                   20.    The satellite system as recited in claim 12, wherein said  
2   burst packet is extracted from said downlink queue using a shuffling method.

1                   21.    The satellite system as recited in claim 12, wherein said  
2   cache includes a plurality of memory locations, each of said memory locations  
3   having a first in, first out queue.

1                   22.    The satellite system as recited in claim 12, further  
2   comprising said cache skip flags to skip moving subsequent packet bursts from  
3   said downlink queue to said cache if the first packet burst for respective cell ID  
4   was not moved due to said respective cache FIFO queue being full. Thus, the  
5   said skip flags preserve a first in first out (FIFO) packet burst order for a given  
6   destination Cell ID.

1                   23.    A method of spot beam hopping packet scheduling  
2   comprising the steps of:  
3                   receiving downlink cell ID and burst memory pointers;  
4                   storing said downlink cell ID and burst memory pointers in a  
5   downlink queue;  
6                   transferring said downlink cell ID and burst memory pointers to a  
7   cache;  
8                   preserving FIFO order for all bursts for a given Cell ID;  
9                   selecting starting point for seed packet burst search in said cache;  
10                  searching said cache for seed packet burst in pre-configured  
11   search order, search range and statistical weighting;  
12                  searching said cache for compatible packet bursts in pre-  
13   configured search order, search range and statistical weighting;  
14                  searching said downlink queue for packet bursts; and

15 filling any empty cache memory with data from said downlink  
16 queue.

1 24. The method of spot beam hopping packet scheduling as  
2 recited in claim 23, further comprising the step of transferring said downlink  
3 cell ID and burst memory pointers stored in said cache to a plurality of pointer  
4 output registers.

1 25. The method of spot beam hopping packet scheduling as  
2 recited in claim 23, further comprising the step of providing packet burst  
3 information to an antenna controller and packet burst content to modulators.

1 26. The method of spot beam hopping packet scheduling as  
2 recited in claim 23, further comprising the step completing and restarting the  
3 said downlink queue search when Cache Depth/2 time slots expire.